- **Risk Management Products (RMP).** The **RMP** will be financially oriented and will develop methodologies for calculating the costs and benefits of implementing PBSD. A major effort will be to combine various levels of risk, performance and hazard to allow a wide range of design objectives to be evaluated as potential bases for new procedures. Research will include studies on reliability, cost-benefit modeling, loss reduction, capital planning, etc. A focus will be to provide owners with tools that can reliably be used to select appropriate performance objectives for projects. The information produced in the RMP should also serve as the basis for the development of a building rating system.

The last two products comprise the end use documents, which are distilled and synthesized from the technical reference products.

- The **PBSD Guidelines.** The Guidelines will be the actual document containing the performance based design procedures. It is intended that this document will be published as a FEMA guideline and can be incorporated into future codes and practice. It will form the technical basis for design and analysis and be written to bring consistency throughout the industry. It will be usable for both new design and existing building retrofit. It will also contain a technical commentary to the Guidelines.

- A **Stakeholders' Guide.** This document will function as a reference and planning guide for owners, financial interests and other non-technical stakeholders. It will include financial tools that permit owners to make funding decisions about buildings using performance based design concepts. The guide will be written for a non-technical audience and contain graphic aids and example applications.

Summary Budget and Schedule

This section summarizes the overall funding request for the development of the PBSD products, and a schedule for completion within ten years. Detailed breakdowns of the cost and duration of each product are contained in the following sections.

The ten-year timeframe for completing the six products is ambitious. It will require that teams work concurrently where possible to reduce the overall schedule. This will mean that the number of people involved with the project will be large. While this creates an administrative challenge, it is consistent with the desire to obtain broad ownership of the resulting guidelines.

Each product contains "essential" and "optimal" funding levels. Material that is essential is required to create a basic framework for PBSD. Without this material, fundamental gaps will be left. These gaps may significantly reduce the likelihood that PBSD will be widely adopted. **The optimal material is very important if PBSD is to be truly effective.** The momentum established with the framework development should be continued, by implementing the optimal tasks. This lesson has been learned through previous efforts at developing guidelines. In each product section, tasks are identified as either essential or optimal, and from these the summary numbers are drawn.

Several tasks consist of supporting programs of research, testing or information gathering.

The funding requests for these tasks represent the costs to set up the programs and to identify an ongoing source of funding for their implementation.

Several outside sources will be tapped for these efforts, including owners' groups, materials and equipment manufacturers, and government agencies.

The budget also provides a general funding breakdown by year. As one of its first tasks, the project steering committee will refine these allocations based on the establishment of the working teams. Because work on all six products is done somewhat in parallel, the steering committee may reschedule tasks and funding as the project progresses.

The funding request is shown in 1998 dollars and will need to be escalated over the duration of the project.

Following the budget is a flowchart showing the relationships between the products. This is a very important part of PBSD development. Rather than a linear process, where the technical documents are developed and the end use documents are prepared following, the flowchart describes a more parallel

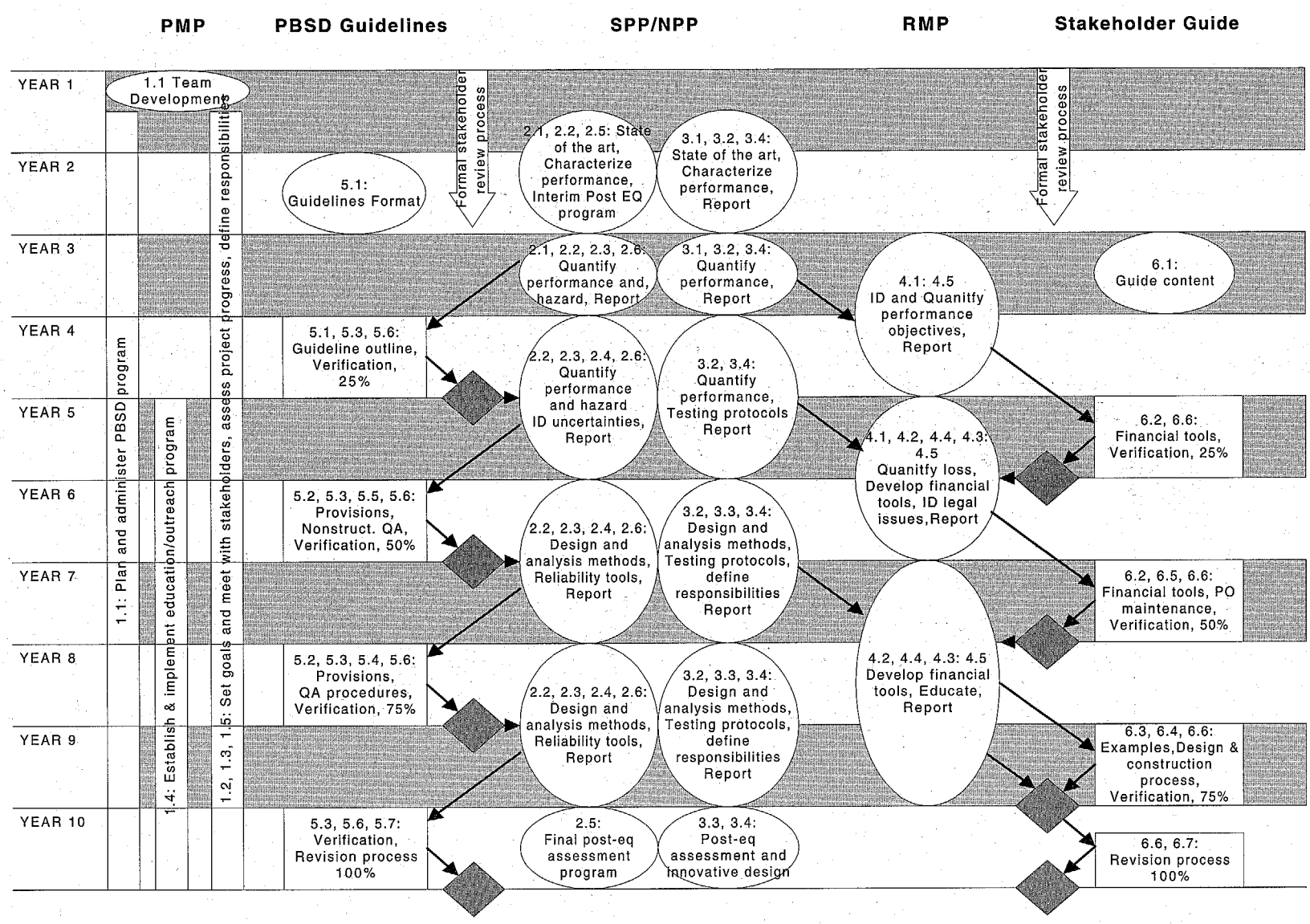
process. At milestones during the technical research, information is gathered and fed into a framework for the Guidelines and Stakeholders' Guide. The Guidelines are then reviewed and verified, and as necessary the direction of the technical work is refined or changed. In similar past projects of this scale, this has allowed a regular review of the material being developed by the stakeholders. The steering committee will have an important responsibility in managing this process. The Planning and Management Program continues throughout the project to ensure proper coordination. The schedule of tasks and subtasks within each product should generally follow the descriptions within the flowchart, but may be revised by the steering committee based on stakeholder review.

The goal of this schedule is not to rigidly define the process, but to identify the relationships between the products and their tasks.

FUNDING REQUEST: SUMMARY TABLE
(DOLLARS IN MILLIONS)

Cost	Product	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
$3.8-4.3	Planning and Management Program	$0.31	$0.36	$0.21	$0.21	$0.45	$0.45-0.61	$0.45-0.61	$0.45-0.51	$0.45-0.51	$0.45-0.51
$6.0-7.5	Structural Performance Products	$0.35	$0.93-1.3	$0.54	$0.70-0.93	$0.70-0.93	$0.70-0.93	$0.70-0.79	$0.70-0.79	$0.70-0.79	$0-0.16
$3.0-4.6	Nonstructural Performance Products	$0.45	$0.7	$0.27	$0.27	$0.27-0.47	$0.27-0.47	$0.27-0.47	$0.27-0.47	$0.27-0.47	$0-0.6
$2.8-4.6	Risk Management Products			$0.85	$0.34-0.60	$0.39-0.76	$0.39-0.76	$0.29-0.53	$0.29-0.53	$0.28-0.52	
$3.5-4.4	PBSD Guidelines		$0.08		$0.91		$0.83-1.13		$0.83-1.28		$0.83-0.98
$1.2-1.9	Stakeholders' Guide			$0.15		$0.17		$0.37-0.62		$0.37-0.52	$0.17-0.42
$20.4-27.3		$1.1	$2.1-2.4	$2.0	$2.4-2.9	$2.0-2.8	$2.6-3.9	$2.1-3.0	$2.5-3.6	$2.1-2.8	$1.5-2.7

Range represents essential and essential + optimal tasks
Values are rounded
Amounts shown are in 1998 dollars



FLOWCHART SHOWING RELATIONSHIPS BETWEEN PRODUCTS AND TASKS

Layout of Product Sections

The following sections are devoted to the six products described above. Each begins with a general description of the product. The description mentions the core material that will be included; however, as development occurs additional or alternative approaches may be desirable. In order to provide some flexibility in project funding, the Plan describes the material as either essential or optimal, as described in the previous section.

A list of tasks follows the product description. A list of primary team members involved with the task and a preliminary budget is shown. Other stakeholders with a more indirect interest are shown in parenthesis. The budget assumes a rate of $130 per person-hour (this includes a markup for support staff, expenses and funding for workshops, travel, etc. as required). Task duration is listed as well. Most of the tasks continue over several years, so that the duration is better considered using the flowchart in the previous section. It is not expected that effort will be continuous over the entire duration of a task. The task budgets are based on teams working at about one-quarter time. Some tasks will require that the teams be larger or smaller or that the effort steps up at some period then relaxes during review cycles. Where this is the case, the budget has been modified accordingly. It will be up to the steering committee to monitor this carefully.

Several tasks include the identification of additional funding sources for the full implementation of post earthquake data collection, instrumentation, component testing, future revisions to the Guidelines, ongoing education efforts, etc. The budget figure shown for each of these tasks includes the team's effort to identify these funding sources and to set up the protocols and goals for these programs. The funds necessary to actually implement the programs may be high (more than $1 million each) and are not part of this *Action Plan*. Sources of funding may include government agencies, research consortia, equipment manufacturers, material suppliers, professional societies, building owner groups, etc.

Many complex issues must be researched and resolved when developing each of the products. Several authors have written issue papers in preparation for the development of this *Action Plan*. The papers describe some of these issues as well as potential paths of resolution. As a reference, they are included in an

appendix to the Plan. Following the description of each of the products, a brief discussion of the main challenges is presented. The product teams will need to devote a special effort to meeting them. The challenges can be grouped topically as follows:

- Analysis and modeling approaches
- Ground motion characterization
- Performance levels and damage state definition and quantification
- Acceptability evaluation procedures and criteria
- Reliability quantification and assessment
- Funding
- Administration
- Education and Incentives
- Data Acquisition

PRODUCT 1 - Planning and Management Program

Currently there is a demand within the stakeholder community for more reliable ways to predict and control building performance. These demands, however, are not clearly articulated and are often conflicting. Clearly, though, there is increasing recognition that problems exist with current design practice. The greatest challenge to creating a successful PBSD program is distilling the most important needs within these demands and synthesizing from them a cohesive guideline for performance based design. A significant effort will be required to ensure that the PBSD guidelines respond to these needs fairly, are accepted by stakeholders and are implemented effectively. The *Action Plan* must be a vehicle to communicate these needs to the entire community, so that the solutions are appropriate and widely acceptable. A formal program will be necessary to educate people about how PBSD can respond to many of their current demands for more reliable and cost effective performance. The Planning and Management Program will consist of the following components:

- *An administrative steering committee to shepherd and promote the development of the Guidelines.*

  The steering committee will create the teams that are responsible for developing the various products described in the preceding sections. It will establish the overall schedule for the project and insure that the efforts by the various working groups are tracking towards the goals laid down in this *Action Plan.*

  The committee will work collaboratively with the stakeholders to create an effective coalition of interests. It will question stakeholders directly in a series of forums about what they see as concerns and benefits. The committee needs to function as facilitator, encourager and promoter to insure adoption.

  The steering committee will not serve as the program manager. It is intended that the funding agency will either directly assume this effort or will assign it to a third party. The committee will work closely with the program manager to ensure good coordination of the project.

- *Stakeholder meetings to gain support from the broad range of participants within the built environment.*

  PBSD will have a much greater chance of success if, rather than being "sold" to an unreceptive audience, it is developed from within the audience itself. A major goal of

this project is to create an end product in which all stakeholders take ownership. To this end, the Planning and Management Program will establish and facilitate forums where stakeholders are queried about their specific needs and asked to participate in the development of each of the products.

- *An education strategy to facilitate the use of the Guidelines.*

  The education strategy will require a concentrated effort of conferences, workshops and publications to raise awareness and gain acceptance of the guidelines. Integration of the guidelines into codes and adoption by local jurisdictions needs to be accomplished in an incremental way yet with a defined timetable and strategy. The steering committee, stakeholders involved with the development of the guidelines and professional educators will lead seminars, write articles and assist with the implementation of the guidelines nationwide.

Task 1.1 – Team development

Task 1.1.1 – Create a steering committee

Description:

The first major task is for a steering committee to be created. This group will remain together for the duration of the project. The goal of the group will be to shepherd the development of the PBSD Guidelines. The committee will include a broad spectrum of people from all stakeholder groups. It is important that the group not be seen as too heavily weighted with any one group. Key to successful implementation of PBSD is input from all users. The group will layout the basic outline for each of the product development teams, and will select the team members and reviewers. These teams will consist of experts on the product material, although diversity will still be important to include different points of view. The steering committee will be responsible for overall project coordination, ensuring that work by each team is produced in a timely manner and has been reviewed for both technical accuracy and for usefulness. The group will develop status report formats for each team to use on a regular basis. It will act as a liaison with other concurrent research projects, to facilitate the free exchange of ideas. It will hold regular meetings to discuss progress of the project and resolve any conflicts. It will serve as a means to transfer information between teams, ensuring that the efforts are complimentary and supplementary.

The committee will coordinate their efforts with the program management structure established by the funding agency.

The committee will review management models for other development projects (SAC, NEHRP Guidelines, FEMA 273, HAZUS, etc.) and assist FEMA in developing the most appropriate model for this effort.

Personnel: Design professionals, Researchers, Contractors, Material suppliers, Financial interests, Owners, Building officials, Government agencies

Priority: Essential
Budget: $1,500,000
Duration: Throughout the project

Task 1.1.2 – Establish product development teams

Description:

The steering committee will provide oversight for the selection of teams to develop each of the products and perform each of the tasks described in this *Action Plan*. The group will establish a means to fill the teams with a wide range of talented individuals expert in their fields. The group will establish terms of compensation and job responsibilities. The group will review the status and progress of the teams on a regular basis. It will make changes to their composition as necessary to maintain effective progress that meets budget and scheduling constraints.

Personnel: Design professionals, Researchers,

Contractors, Material suppliers, Financial interests, Owners, Building officials, Government agencies

Priority: Essential
Budget: $100,000 (budget for the product development teams themselves are included within associated tasks)
Duration: Throughout the project

consensus about the style of presentation.

Personnel: Design professionals, Researchers, Material suppliers, Architects, Contractors, Financial and insurance interests, Owners, Building officials, Government agencies

Priority: Essential
Budget: $200,000
Duration: 2 years

Task 1.2 – Set goals with stakeholders

Description:

The steering committee will convene a series of workshops with stakeholder representatives through which several issues will be resolved. These include identifying the most important concerns owners and other financial stakeholders have when managing risk, and the benefits that these stakeholders expect from PBSD (reducing construction costs, optimizing overall life-cycle costs, developing a building rating system, minimizing down-time, etc.). The team will also identify the positive and negative aspects of current codes and design standards from design, cost and usability points of view. The workshops will also focus on establishing levels of analysis and design complexity. This will require that a broad section of the stakeholder communities be involved. A goal is to be able to quantify the level of effort that will be required of the designers in terms of cost, time and sophistication, so as to be as flexible as possible. The team will reach a

Task 1.3 –Assess project progress with stakeholders' groups

Description:

The steering committee will identify interested parties from all the stakeholder communities and bring them into the PBSD development process. The team will establish regular lines of communication and dissemination of information. It may tap from these parties, people to serve on other task teams.

The steering committee will hold a series of meetings with the stakeholders' groups throughout the project to gauge and review the progress of the project. The goals will be to present the status of the project to the stakeholders, to insure that the project continues to address their needs and to give them a voice in refining the project's direction. To achieve the most efficiency, the meetings should be conducted by professional facilitators. The team will establish recording procedures and formats for agendas, presentations, minutes, etc. The team

will collect and disseminate the information developed in the meetings.

The steering committee will make a special effort to remain in contact with the stakeholders' groups throughout the project with correspondence, ad hoc meetings, etc. so that at no point does the project disconnect itself from their input. Gaining broad acceptance of PBSD will only be possible through continual interaction with the people who will be using it.

Personnel: Design professionals, Researchers, Financial interests, Owners, Contractors, Material suppliers, Building officials, Government agencies

Priority: Essential
Budget: $600,000
Duration: On a regular basis throughout the project.

Task 1.4 – Develop education and incentive programs

Task 1.4.1 – Develop an education program

Description:

The steering committee will disseminate information about PBSD to users. This will be accomplished with a variety of teaching tools including, publications, tutorials, seminars, workshops, continuing education classes, multimedia tools, etc. The team will make a concerted effort to reach those outside the engineering community, including architects, contractors, owners, financial interests and material suppliers. It also must reach users in all regions of the country.

The steering committee will develop core teaching materials and identify funding sources to provide ongoing educational efforts. Training materials should be professionally developed and be of the highest quality. The team will identify and train teachers from a broad range of backgrounds to present the material. The team will be composed of experts with specialization in outreach, dissemination, and education. It will receive input from the design professionals, researchers and others who have developed the technical and end-use products.

The steering committee must also reach indirect stakeholders such as building occupants, regulatory agencies and the public at large. Material should utilize various media to clearly explain PBSD. The team will identify funding sources to permit an ongoing outreach effort beyond the ten-year duration set forth in this *Action Plan.*

Personnel: Outside experts with specialization in outreach, dissemination, and education. (Design professionals, Researchers, Contractors, Material suppliers, Financial interests, Owners, Building officials, Government agencies)

Priority: Essential
Budget: $1,300,000
Duration: 6 years

Task 1.4.2 – Develop an incentive program for using PBSD

Description:

The steering committee will establish a collaborative program by which the benefits of using PBSD will be spread among all the stakeholders involved. It will identify funding sources, both private and public, which will offer incentives for using PBSD, especially in the short term when it is still seen as an emerging technology.

The steering committee will establish cooperative relationships between buyers, sellers and installers, to develop better performing nonstructural components. Among these three groups sources will be identified to create a fund for developing innovative designs.

Personnel: Outside experts, Design professionals, Researchers, Contractors, Material suppliers, Financial interests, Owners, Building officials, Government agencies

Priority: Optimal
Budget: $300,000
Duration: 3 years

Task 1.5 – Clarify responsibilities between stakeholders

Description:

The steering committee will write a plan for the division of responsibility between designers, contractors, manufacturers, installers and owners so that at all stages of a building's life, responsibility for the seismic performance of the structural and nonstructural components is maintained. It will identify the effects that this division will have on these groups, practically, financially and with respect to liability. The team will develop a "hand-off" program so that information is smoothly passed between groups. A goal of this task will be to find ways for each of these groups to work collaboratively toward the same ends.

Personnel: Design professionals, Contractors, Material suppliers, Owners, Building officials, Government agencies

Priority: Optimal
Budget: $200,000
Duration: 2 years

Challenges

- *Funding*

  The government cannot and should not fund all of the research and support all of the incentive programs that will be necessary to implement PBSD. Many stakeholders will benefit from PBSD and should share in these costs. It will be a challenge to identify sources of funding for these projects from within the other stakeholder communities. Stakeholders will need to be convinced that spending money on research will be in their long-term financial interests.

- *Administration*

  The aggressive schedule and need for consensus building require that many people be involved with the project. Management of these teams and their interests will perhaps be the most difficult challenge. The steering committee will need to be diverse and must be able to reach consensus on major issues. Substantial energy should be devoted to building strong teams and developing relationships within them. These groups will be together for many years, so they need to work well together. A strong management structure and project manager will be essential to insure that this Plan is implemented properly and remains on schedule and on budget.

  Issues of equity and responsibility will be important challenges. Each of the stakeholders needs to see PBSD as a "win" for them. Compromise will be an inevitable part of the process. The steering committee must insure that each group is heard and its needs accounted for.

  Understanding changes in liability will be a major challenge, as groups become responsible for different things during the entire life of a building. The legal ramifications of these changes may affect how widely PBSD is used. The steering committee must address these concerns early on and with compromises that satisfy each group but do not reduce PBSD to an ineffective tool. The group will need to bring in legal expertise to help resolve this issue.

- *Education and Incentives*

  Overcoming long held beliefs about the nature and importance of design and about its relation to other aspects of financing, construction and maintaining a building will be difficult. The steering committee and education groups must be supporters of the process and its expected benefits.

  Many potential PBSD users will be overwhelmed by the changes required of them. It will be important to allow for an incremental infusion of the guidelines into general use and into building codes. The steering committee will face the challenge of bringing PBSD online quickly yet in ways which are not threatening to users.

PRODUCT 2 - Structural Performance Products

These products will form the core reference material of the PBSD Guidelines. They will include three main areas of focus:

- *Methodologies for quantifiably and reliably defining structural performance and acceptability criteria on a building and component basis.*

  This effort will define performance levels in terms of drift, damage, ductility or other parameters for each building type. The work will synthesize the results of analytical and experimental data. It will consider the variability and uncertainties involved, with the goal of obtaining reliable estimates of material, component and system performance.

- *Analytical and design procedures by which engineers can predict a building's expected performance with well defined reliability.*

  Performance engines will need to be developed to permit structural evaluation by the entire engineering community. It is important that they be sophisticated, but broadly usable. Methodologies need to be developed for design of new and retrofit of existing buildings. Techniques need to account for current computer technology that is widely available and that which can be expected in the future.

- *Tools that can more reliably predict and appropriately quantify expected ground motions.*

  These tools will characterize the seismic demand requirements for linear and nonlinear analyses, using response spectra and time-histories. Ground motion parameters that correlate to performance will be identified and quantified. Simplified representations of these parameters into static base shear and lateral force distribution formulas will also need to be developed. Issues of reliability, uncertainty and confidence levels need to be incorporated into the determination and effects of ground motion. The information will have to be flexible enough to be used by a wide audience. A procedure for data collection through instrumentation will be developed.

It will be highly desirable to identify other sources of funding to promote basic research in the areas defined by the tasks. These sources may include government agencies, the materials industry, and others. The budget amounts shown for each will likely be sufficient to achieve a working framework for PBSD, but expanded research will broaden its scope and usefulness.

Task 2.1 – Identify current PBSD information and additional research needs

Task 2.1.1 – Assess the state of the art in structural performance and analysis

Description:

The team will gather existing information on structural analysis and design methods and identify gaps in current knowledge. A strong effort will be made to use available information so that research funding can be most efficiently spent. The current state of the art should not define the scope of this project or limit the direction research might take, but rather allow researchers to avoid unnecessary duplication of effort. The team will also assess the usefulness of available information on material performance, component acceptability, geotechnical parameters and hazard quantification. An effort will be made to characterize the reliability of existing procedures and information.

Personnel: Design professionals, Researchers

Priority: Essential
Budget: $150,000
Duration: 1 year

Task 2.1.2 – Develop a research plan to advance the state of the art

Description:

Once gaps in existing knowledge have been identified, the group will develop a research plan to fill them. The goal will be to develop a road map of research by which the tasks within this *Action Plan* can be accomplished. The plan will be detailed enough to be used by stakeholders, laying out tasks and schedules. An effort will be made to identify outside sources of funding to augment the budgets assigned to each task within the Plan, considering public and private resources.

Personnel: Design professionals, Researchers,

Priority: Essential
Budget: $150,000
Duration: 1 year

Task 2.2 – Develop means by which to characterize, quantify and predict performance

Task 2.2.1 – Develop performance characterization

Description:

The team will reach consensus on the definitions of performance to be used as the basis for PBSD. These characterizations will be quantified in a later task. The goal in this task is to agree on concepts such as life safety, immediate occupancy, etc. The team

will decide what these terms mean in relation to casualties, capital loss, down time, and other important parameters. Reaching a firm decision on performance definitions is critical to the rest of the project. It therefore must incorporate the opinions of all stakeholders. Meetings among stakeholder groups will be held to determine which measures of performance are considered the most important and how they relate to analytically predictable behavior. These performance measures will later be coupled with hazard information from Task 2.3, to obtain performance and overall design criteria.

Personnel: Design professionals, Researchers, Owners, Building officials, Government agencies, Financial interests

Priority: Essential
Budget: $250,000
Duration: 2 years

Task 2.2.2 – Develop building and component acceptance criteria

Description:

The team will gather and review existing information on acceptance criteria, and identify gaps in current knowledge. Research will be targeted to fill in these gaps and will include both analytical and empirical processes. Collaboration with testing programs will be important to obtain useful information on component behavior.

Results of this task should be verified with current knowledge about material behavior.

A strong effort will be dedicated to extrapolating component behavior, which is more clearly known, to building behavior, which currently contains more uncertainty. A goal will be to identify and quantify in practical terms criteria for overall building performance.

Personnel: Engineers, Researchers, Material suppliers

Priority: Essential
Budget: $1,000,000
Duration: Throughout the project

Task 2.2.3 – Develop geotechnical predictors of building performance.

Description:

The team will gather and review existing information on the effects on building performance of subsurface conditions. These will include the effects of soils, soil-structure interaction, and foundations. The team will identify gaps in current knowledge. Research will be targeted to fill in these gaps and will include both analytical and empirical processes. A strong effort will be dedicated to identifying ways to reduce uncertainties related to geotechnical and substructure analysis and design.

Personnel: Engineers, Researchers, Material suppliers

Priority: Essential
Budget: $650,000
Duration: Throughout the project

Task 2.2.4 – Quantify performance levels.

Description:

Using the definitions developed in Tasks 2.2.1 and 2.2.2, the team will quantify performance levels using appropriate parameters (drift, damage, loss, business interruption, casualties, etc.). The goal in this task is to set the performance parameters so that the evaluation and design methodologies developed in the PBSD Guidelines product can be targeted to definitive numerical quantities.

Personnel: Engineers, Researchers, Government agencies, Building officials,

Priority: Essential
Budget: $450,000
Duration: Throughout the project

Task 2.2.5 – Develop analytic methodologies for achieving performance levels

Description:

The team will fill in the gaps in existing knowledge identified in Task 2.1.1. Research will consist primarily of analytical efforts and development of practical tools. The team will identify promising new techniques and devote research to making them usable within the PBSD framework. A forum will be held, bringing together engineers and building officials to discuss design and analysis methodologies. The purpose of this activity is to understand the broad range of engineering styles used throughout the country.

Following this, the team will develop design and analysis methodologies, which will be usable by the entire design community. A focus will be on developing comprehensive and accurate methods that can be refined and made more practical within the Guidelines product. The methods will include consideration of geotechnical conditions and design of foundations as well as methods for practical assessment of reliability and safety. Modeling strategies will also be developed in this task. The team will keep in mind the limitations of computer applications currently available and anticipated in the future. It will account for the financial investments the design community is able to make in obtaining modeling technology. It will also consider architectural interests in the design process and the engineering limitations that may result.

Personnel: Engineers, Researchers

Priority: Essential
Budget: $1,100,000
Duration: Throughout the project

Task 2.2.6 – Develop analytical predictors of existing building performance

Description:

This effort will proceed in a similar manner to Task 2.2.5, but will focus on existing buildings. The team will research successful examples of retrofit and identify features that should be employed typically. It will quantify uncertainties within the existing built environment.

Personnel: Engineers, Researchers (Material suppliers)

Priority: Optimal
Budget: $650,000
Duration: Throughout the project

Task 2.3 – Develop hazard quantification and prediction methodologies

Description:

The team will develop processes to obtain ground motion information for use in PBSD. It will identify and describe in measurable terms the parameters of ground motion which have the most important effects on buildings. The team will create a standard for characterizing ground motion and will include issues of damping, nonlinearity, duration effects, etc. The team will develop rules for applying ground motion information, to create uniformity of use. Working with members of the earth sciences community, the team will put substantial effort into understanding, quantifying and building a consensus on the effects of edges and basins, soft soils, soil-structure interaction and near-fault ground motion. Similarly, methods to quantify the amount of and consequences of permanent ground displacement will be developed.

Personnel: Engineers, Researchers

Priority: Essential
Budget: $650,000
Duration: Throughout the project

Task 2.4 – Identify uncertainties and develop practical means to assess and increase performance reliability

Task 2.4.1 – Develop means to check and increase reliability

Description:

The team will identify and quantify uncertainties in quantifying seismic hazards, building response and the variability of construction quality. This information will be developed in conjunction with the Risk Management Products, which will focus on the cost implications of these uncertainties. The team will research existing reliability techniques, identifying usable information and gaps. The team will use reliability theory to select and refine the design events and material acceptability. The team will develop simplified methods of reliability analysis, or identify software needs, understandable and usable by engineers. These may include equations, fragility curves for building classes and performance levels, and other tools to help the engineer prepare a design with a defined level of reliability and confidence. The team will also evaluate and reach consensus on appropriate target levels of reliability for specific performance levels (such as life safety or immediate occupancy) and for various building classes and uses.

Personnel: Researchers, Financial interests

Priority: Essential
Budget: $650,000
Duration: 6 years

Task 2.4.2 – Identify methods that optimize constructability, repairability and QA/QC

Description:

The team will evaluate design methodologies focusing on constructability and repairability. The goal will be to identify structural systems that have predictable building performance and can be well controlled in terms of quality. The team will also make a strong effort to identify structural systems that minimize repairability costs following a major event, the goal being to reduce an owner's overall life-cycle costs and downtime.

The team will identify design processes and construction techniques that reduce quality or increase uncertainty in building performance to discourage their use. It will develop specifications and aids to assist designers, owners and contractors in controlling quality during construction. It will develop sample QA/QC programs using existing information where possible.

Personnel: Design professionals, Researchers, Owners, Building officials, Contractors

Priority: Optimal
Budget: $500,000
Duration: 6 years

Task 2.4.3 – Establish a separately funded effort for materials and component testing

Description:

The team will identify separate sources of funding, focusing on materials suppliers, to perform materials testing to fill in gaps in the current state of knowledge. The effort will include evaluating and investigating component performance in terms of quantifiable parameters such as stress, strain, ductility, methods of preparation, etc. The goal is to establish measures of performance that can be used in the analysis and design methodologies described in previous tasks. The team will develop testing protocols for obtaining and cataloguing information.

Personnel: Design professionals, Researchers, Materials suppliers

Priority: Essential
Budget: $400,000 (does not include testing)
Duration: 3 years